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PERIODICAL TAPPING OF HEVEA.

1. *The experimental basis of periodical tapping.*

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2. *The effect of alternate periods of tapping and resting on the quality of the rubber.*

B. J. EATON AND R. O. BISHOP.

Part I.—*The Experimental Basis of Periodical Tapping.*

Periodical tapping, i.e. where periods of daily tapping alternate with periods of rest, has of late years attracted much attention, and alternate monthly tapping on a half of the circumference has become the standard system on the East Coast of Sumatra. The historical development has been extensively treated by Maas (1). The purpose of the present paper is to show the basis on which this system rests as shown by experiments on the estates of the Hollandsch Amerikaansche Plantage Maatschappij; (property of the United States Rubber Plantations, Inc.) in Sumatra. Several past and present members of the company's research staff have contributed to the carrying out of the experiments described below, in particular, M. D. Knapp, who initiated Experiment 1 and E. M. Blair who has been in direct charge of the experiments in later years. For several years prior to 1922 the system of daily tapping a single cut on one third of the circumference was the standard system in Sumatra and had been shown to be the best yielding daily system consistent with conservative use of the bark. This system therefore formed the basis of comparison in the development of the new system.

Experiment. 1.—This experiment was started in July 1918 on Kisaran estate for the purpose of comparing one-third daily with one-half alternate day which preliminary experiments had indicated as a

(1) Het tapsysteem van Hevea brasiliensis op proefondervindelijken grondslag—Maas. Archief voor de Rubbercultuur in Ned. Indie, Jaar 9, No. 1, Januari 1925.

(The tapping system of Hevea on an experimental basis).

possible alternate system. The experiment was started on young (4 year old) trees not previously tapped and consisted of fifteen rows each of 100 trees of the one system alternated with fifteen rows of the other system. The alternate day trees were all tapped the same day and rested the next day. Each tapper tapped an equal number of trees of each system to eliminate variation due to the coolie. The maximum difference possible from accidental variations was calculated to be 6 per cent.

The tapping surfaces were laid out as follows :—

One-third *Daily System.*—Bark consumption $1\frac{1}{2}''$ per month.

1st One-third.	13″ allowing 1″ for opening and 3″ from the ground, giving 9″ of tappable virgin bark	6	months.
2nd One-third.	22″ giving 18″ of tappable virgin bark	12	,,
3rd One-third.	28″ giving 24″ of tappable virgin bark	16	,,
4th One-third.	28″ giving 15″ of tappable virgin bark	10	,,
		44	,,

Leaving 9″ renewed bark 44 months' renewal.

5th One-third. 28″ giving 6″ of tappable virgin bark, 18″ renewed bark 48 months old.

All subsequent surfaces laid out at 28″ giving 48 months' renewal.

One-half *alternate day system.*—Bark consumption $\frac{3}{4}''$ per month.

1st half. 13″ giving 9″ of tappable virgin bark.
2nd ,, . 22″ giving 18″ of tappable virgin bark.
3rd ,, . 22″ giving 9″ of tappable virgin brrk.

Leaving 9″ renewed bark 4 years old.

All subsequent surfaces at 22″ giving 4 years' renewal.

The relative yields of the two systems are shewn in Table 1 below.

TABLE I.

System.	1918 half year.	1919	1920	1921	1922	1923	1924	1925 to June.	Total July 1918 to June 1925.
One-third daily.	100	100	100	100	100	100	100	100	100
One-half alternate day.	74.9	89.3	96.0	99.8	97.1	93.4	103.8	109.5	98.7

Thus while in the early years there is some loss from the half circumference alternate day as compared with the one-third daily, this is made up in later years and, over seven years, the yield is practically the same, with a tendency to be higher in future. The increased production in later years is probably connected with a better bark renewal, which was shown by measurements in January 1923, on bark which had renewed for two years, of 450 trees in each plot to be 7 per cent better in the alternate day plots.

In practice a longer renewal period than the four years given in these plots would be allowed, but since this means going higher on the tree, where the yield is less, the daily system (which would commence higher) would be prejudiced relatively to the alternate-day system.

The advantages of the longer cut and the alternate-daily tapping system were first evident about 1921 and it was also at this time that the alternate-period systems first began to arouse interest and the possibility of substituting an alternate-period system for an alternate day system was considered. This led to the planning of the two following experiments.

Experiment 2 (a).—This experiment was carried out on nine years' old rubber on Soengei Baleh estate, beginning March 1921 on a whole division of 630 acres. The tapping cut was on one-third of the circumference. The division was divided into fifty-eight fields, each tapped by one coolie. Each field was divided into two equal parts, which, in the odd fields, were tapped on alternate days and in the even fields, in alternate months. The experiment ran for ten months, and the percentage relation of the yields was :—

Alternate day	...	100
Alternate month	...	104

The maximum accidental error was calculated to be 5 per cent.

Experiment 2 (*b*).—This experiment was started in March 1922 on six years' old rubber, not previously tapped. Cuts were laid out on one half of the circumference. The total area was fifty acres divided into ten tapping fields, each divided into two halves, tapped alternate-daily in the odd fields and alternate-monthly in the even fields, as in the previous experiment. In order to eliminate errors due to the coolies, they were rotated monthly, thus, after ten months, each coolie had tapped each field.

This experiment ran for thirty five months until January 1925, at the end of which time the percentage relationship of the yields was :—

Alternate day	...	100
Alternate month	...	105.9

Thus while the differences are not outside the range of accidental error, in each experiment, the alternate-month system gave

more than the alternate-day and it may be safely concluded that it is equally as good and probably a little better. The alternate-month system is preferable from an organisation stand-point and enables various economies to be made, since attention need be concentrated only on the area in tapping during the month.

It appeared that the half alternate-month sytem was a desirable one compared with the one-third daily since it entailed no loss in yield and effected a very great economy in tappers and supervision.

It still remained to be shown whether the period of alternation chosen, viz. one month, was the best and for this purpose a further experiment was laid out.

Experiment 3.—This experiment was started in May 1923 on an area of fifty acres of uniform twelve years' old rubber on Boenoet estate. The tapping system was one third of the circumference and all tapping cuts at the beginning of the experiment were laid out with the lower end of the cut at 28″ from the ground. Bark consumption was regulated at 2″ per tapping month. There were five series of plots:—

(1) Half month tapping, half month rest.
(2) One month tapping, one month rest.
(3) Two months tapping, two months rest.
(4) Four months tapping, four months rest.
(5) Six months tapping, six months rest.

Each series consisted of twelve rows of one hundred trees i. e. a total of sixty rows, every fifth row being the same series. The area was divided into six fields of ten rows each, of which five rows were always in tapping and five resting, the period of tapping or rest of a given row being determined by the series to which the row belonged. Each field was tapped by one coolie who tapped across the rows, thus tapping all series at the same time. The latex was collected separately from each series and each day made into one large sheet for each series, the sheets being subsequently dried and weighed. Owing to previous experiments which affected the bark renewal on the next tapping surface, the maximum duration of this experiment was limited to two years, and it therefore ended on April 30th, 1925, after twenty-four cycles of tapping and rest of half month periods, twelve of monthly, six of two monthly, three of four-monthly and two of of six-monthly periods. The percentage difference between two series, which could be due to accidental variation, was calculated to be 6.5 per cent over a minimum of six months.

The relative yields of the various series for the two years are shown below, expressed as percentages of the alternate-month series:—

Alternate half months	...	100.9
Alternate months	...	100
Alternate two months	...	99.5
Alternate four months	...	91.6
Alternate six months	...	86.8

It will be seen that there is no appreciable difference in the yield of the first three periods, but that the four-month and six-month periods give distinctly lower yields. It is possible that, over a longer

period, these longer alternations of tapping and rest might show improved figures since, in the present experiment, they passed through only three and two complete cycles respectively.

It is evident however that, initially at any rate, loss would follow the adoption of these long periods, but periods up to two months can be adopted with safety.

Notes on the concentration of the latex in Experiment 3.—The different periods of rest and tapping have a marked effect on the concentration of the latex. In the experiment, daily records were not kept but, from the monthly average concentrations given below, the effect of the varying periods is well shown :—

TABLE II.

Month.	Percentage of dry rubber in latex.				
	Series No. 1.	Series No. 2.	Series No. 3.	Series No. 4.	Series No. 5.
1923					
May -	40.8	**37.2**	38.8	39.2	38.7
June -	41.8	**41.7**	**37.6**	38.0	37.6
July -	44.2	**42.2**	44 0	38.0	37.7
August -	44.9	**43.9**	**40.0**	**39.1**	38.5
September -	42.5	**41.7**	41.7	42.7	35.6
October -	42.4	**41.3**	**37.6**	38.7	**36.1**
November -	42.0	**38.3**	44 3	36.4	42.7
December -	41.5	**41.7**	**36.6**	**35.6**	39.2
1924					
January -	42.2	**39.9**	42.6	44.9	38.8
February -	42.3	**40.8**	**37.1**	37.3	38.0
March -	40.5	**40.5**	42.9	38.0	39.0
April -	40.6	**39.6**	**36.6**	**35.3**	**34.7**
May -	39.4	**37.9**	40.2	41.6	40.8
June -	38.9	**38.6**	**36.1**	36.7	34.0
July -	40.6	**38.5**	41.8	35.1	33.5
August -	41.1	**40.4**	**37.5**	**37.6**	35.0
September -	37.5	**36.8**	39.9	38.6	31.8
October -	38.5	**38.8**	**36.9**	36.9	**34.5**
November -	38.7	**37.9**	41.2	32.7	39.2
December -	38.0	**36.4**	**32.8**	**31.9**	32.3
1925					
January -	38.4	**37.3**	39.3	40.0	32.5
February -	38.4	**37.4**	**33.0**	32.6	32.6
March -	38.8	**37.0**	38.8	33.4	33.9
April -	38.9	**37.1**	32.8	32.7	31.6
Two year period -	39.9	38.7	38.1	36.6	35.3

Series 1, tapped ½ month, rested ½ month.
„ 2, „ 1 „ „ 1 „
„ 3, „ 2 months „ 2 months.
„ 4, „ 4 „ „ 4 „
„ 5, „ 6 „ „ 6 „

Figures in heavy type indicate change of plots from tapping to rest period and vice versa. For series No. 1, this is every half month and cannot be shown.

It will be seen that, with the longer periods, the concentration is always higher in the first month after tapping commences and diminishes up to the last month before the rest period. The daily figures would show this feature in more exaggerated degree. The shortest period gives the highest average concentration over the whole period. The question arose as to whether these differences were correlated with any variation in quality, and this experiment offered a good opportunity of investigation from the strictly comparable series of samples, regarding the effect of various periods of rest and tapping on the quality of the rubber. At the beginning of the second year, in May 1924, resting plots of all series of the experiment began to be tapped again on the same date, the only time when this happened during the course of the experiment. The rubber for each series for each day of the month of May was therefore kept separate and vulcanisation tests made, which are given in the second part of this paper.

Summary.

The yield of alternate period tapping either with half-month, one month, or two-month periods on a half of the circumference is equal and possibly slightly superior to that of daily tapping on one-third of the circumference.

Alternate period tapping causes fluctuations in the concentration of the latex which is highest immediately after the rest period and thereafter gradually falls. The highest average concentration for a complete tapping cycle is given by the shortest period.

Part II.—The Effect of Alternate Periods of Tapping and Resting on the Quality of the Rubber.

It has been shown in Part I of this paper that alternations in the tapping and resting of rubber trees cause changes in the concentration of the latex and that the yield of dry rubber fluctuates according to the cycle of tapping and resting

It is also an established fact that the composition of the latex, apart from the rubber content, is affected by continued tapping and it is probable that such alteration in composition will affect the vulcanising capacity of the rubber. It has previously been shown for example that the yellow coloured latex from newly opened cuts

possesses vulcanising properties distinctly different from the white latex from normal tapping. It was therefore considered desirable to conduct vulcanisation tests on samples of rubber obtained from the field experiments on periodic tapping described in Part I. Similar experiments have been carried out by de Vries. ("Rubber van Periodentap" by O. de Vries, Archief voor de Rubberculture in Ned. Indie, Jaar 8, No. 10 October 1924).

Our conclusions from this investigation are similar to those of de Vries, except that in the present experiments, the fluctuations in the vulcanising capacity of the samples are greater than in the case of the samples examined by de Vries.

Vulcanisation Tests.—Samples of rubber were received and tested for each day of the month of May 1924 except the 1st. 2nd. 3rd. 5th. 6th. 7th. 16th. and 17th. The 1st. and 16th. were regular holidays and no tapping was done on these days. The 3rd was a rainy day and no tapping was done. Unfortunately the 5th. 6th. and 7th. were also holidays in this particular month, owing to the Lebaran Poewasa. Vulcanisation tests were however made on samples of May 2nd. at the Boenoet factory of the United States Rubber Plantations, Inc., and are summarised below. Vulcanisation tests carried out at Boenoet, using a Scott rubber testing machine (strip test pieces) with samples of the rubber of the first day's tapping (May 2nd) of each series gave the following results :—

—	Series 1. ½ month period.	Series 2. 1 month period.	Series 3. 2 month period.	Series 4. 4 month. period.	Series 5. 6 month. period.
Optimum time of cure at 140° C as judged by maximum product (tensile strength × elongation	2¾ hrs.	3 hrs.	3 hrs.	3¼ hrs.	3½ hrs.
Maximum tensile strength in lbs. per square inch.	2832	2923	3039	3226	3291.

In all cases the maximum tensile strength was given at the optimum cure, except in Series No. 1, where it was given at 3 hours. All the above figures are the average of four test pieces.

The optimum time of cure shows a regular progressive increase with length of the rest period, as also the maximum tensile strength, a feature which is not evident in samples of subsequent days.

Description of rubber samples:—The samples of rubber examined from these plots consisted of "first" latex, coagulated with acetic acid, milled into sheets and air-dried for a month. The air-dried sheets were then creped and dried in a vacuum dryer.

The plots from which samples were collected all started tapping on May 2nd, after rest periods varying with the series, and, with two exceptions, were tapped at the same height, all having had an equal number of tapping and rest periods. (A plots). The exceptions were the plots of Series No 4 which had two rest periods and only one tapping period, (B plots) and were tapped 4 ins higher than the others, and the "Series No 1" plots which changed to the B plots on the 17th. May and were thereafter 1 inch higher than the Series Nos. 2, 3 and 5 plots.

Experimental:—The samples were broken down and mixed with sulphur on the mixing rolls, without further washing and drying. The usual mix, ten parts of rubber to one part of sulphur, was adopted and the samples vulcanised at 140°C in a steam autoclave and tested on the Schopper machine 24 hours after vulcanization.

After determination of the optimum time of vulcanisation by reference to a standard stress-strain curve, further samples were vulcanized at the optimum time and twenty test rings were broken on the Schopper machine, in order to ascertain the variability in tensile strength. The "True Mean" of all the Breaking Loads and Elongations at Break were determined for each sample.

The "Standard Deviation" of each series of figures from the "True Mean" has also been calculated and, from these results, the "coefficient of variability" of each set of tensile strengths is recorded. On account of space, only the figures for variability of "Breaking Loads" are recorded in the table.

The results obtained are recorded in Table III and illustrated in Diagrams 1A, B, C, D, E and Diagram II. (1)

The irregularities in rate of cure, shown in Diagrams I, may be due to variation in maturation of the samples, which were all prepared originally in sheet form and dried before being creped.

Diagram II represents the idealised curves for rates of cure illustrated by the irregular curves in Diagram I. These curves have been drawn by averaging figures for pairs of days and smoothing any irregularities, in order to illustrate more clearly the general tendency in increase of rate of cure as influenced by the previous resting period in each series. In each series the curves show a marked depression at about the 14th day of tapping, again increasing up to the 18th day. This would appear to indicate the influence of some unknown factor, such as climatic conditions, during this period. These curves would have been of more interest, if a further series of samples could have been examined for the later stages of tapping in the case of the

(1). The curves in Diagrams 1 B C D E should have a break on the 16th and 17th since the trees were not tapped and no samples were examined. The curves in Diagram I A have been separated, since they represent A and B plots.

TABLE III.

COMPARISON OF RUBBER SAMPLES OBTAINED FROM TREES TAPPED WITH DIFFERENT INTERVALS OF TAPPING AND RESTING.

Results showing Optimum Times of Vulcanisation and Mean Breaking Loads.

Date of Tapping May 1924.	Plot 1A Alternate ½ month.			Plot 1B Alternate ½ month.			Plot 2A Alternate month.			Plot 3A Alternate 2 months.			Plot 4B Alternate 4 months.			Plot 5A Alternate 6 months.		
	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.	Time of cure in minutes.	Mean B-L Kgs. per sq. M.M.	Coefficient of variability for Deviation on Mean of Breaking Loads.
4	180	1.15	22	..	..	...	165	1.22	23	165	1.11	7	165	1.22	5	180	1.36	11
8	165	1.19	13	...	...	...	180	1.15	5	180	1.35	6	180	1.22	5	195	1.34	9
9	165	1.15	15	...	.	...	165	1.20	9	165	1.22	5	180	1.33	27	180	1.28	9
10	180	1.30	3	..	...	...	150	1.16	6	180	1.20	11	165	1.17	7	195	1.34	6
11	180	1.16	13	..	..	...	165	1.24	5	165	1.30	6	165	1.35	3	150	1.32	6
12	165	1.20	9	.	...	...	165	1.09	9	165	1.18	4	165	1.36	9	180	1.31	5
13	150	1.27	13	...	..	...	150	1.37	8	150	1.41	5	165	1.27	19	165	1.38	3
14	150	1.41	5	..	...	..	150	1.30	9	150	1.39	0	150	1.37	11	150	1.40	5
15	150	1.33	6	..	...	...	150	1.49	5	150	1.20	30	150	1.31	3	150	1.39	5
18	..	...	...	180	1.29	6	150	1.09	18	165	1.42	3	165	1.33	7	165	1.39	6
19	...	...	...	195	1.32	8	165	1.07	21	165	1.18	39	180	1.33	11	165	1.31	5
20	...	...	..	165	1.14	2	150	1.24	14	150	1.28	6	150	1.32	14	150	1.31	6
21	..	..	..	150	1.28	3	150	1.37	2	120	1.35	10	150	1.38	4	135	1.46	4
22	..	...	...	165	1.23	13	150	1.39	7	150	1.39	9	150	1.43	2	150	1.50	6
23	...	...	...	165	1.28	7	165	1.20	31	150	1.40	3	150	1.24	33	150	1.36	54
24	...	...	..	165	1.28	7	150	1.19	21	150	1.39	6	165	1.21	22	150	1.25	11
25	...	...	...	165	1.21	20	150	1.04	34	135	1.26	5	150	1·46	2	165	1.12	34
26	...	...	..	150	1.33	5	135	0.95	42	150	1.35	7	150	1.28	21	150	1.29	13
27	...	...	...	135	1.21	12	135	1.43	6	135	1.26	16	135	1.33	7	135	1.31	31
28	...	...	...	135	1.41	3	135	1.36	8	120	1.26	5	120	1.35	5	120	1.32	18
29	...	..	..	135	1.27	11	135	1.37	7	135	1.13	9	135	1.36	5	105	1.25	8
30	...	...	...	135	1.30	3	135	1.37	6	135	1.29	6	150	1.36	0	105	1.25	15
31	...	..	...	135	1.19	6	135	1.26	8	135	1.23	22	120	1.42	3	105	1.33	5

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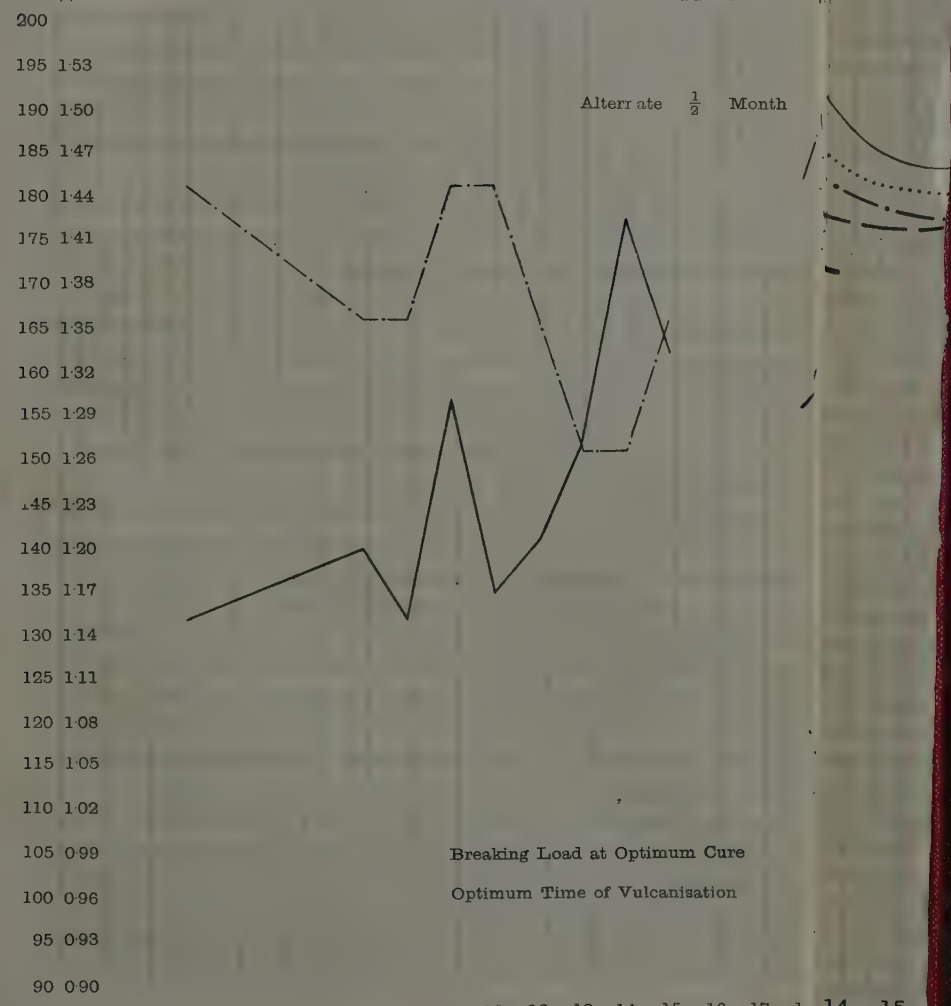

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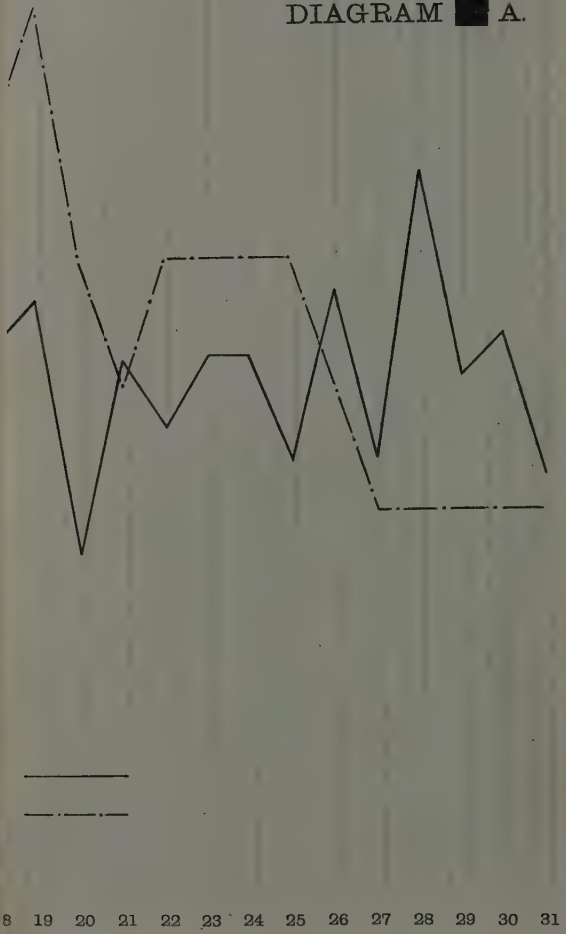

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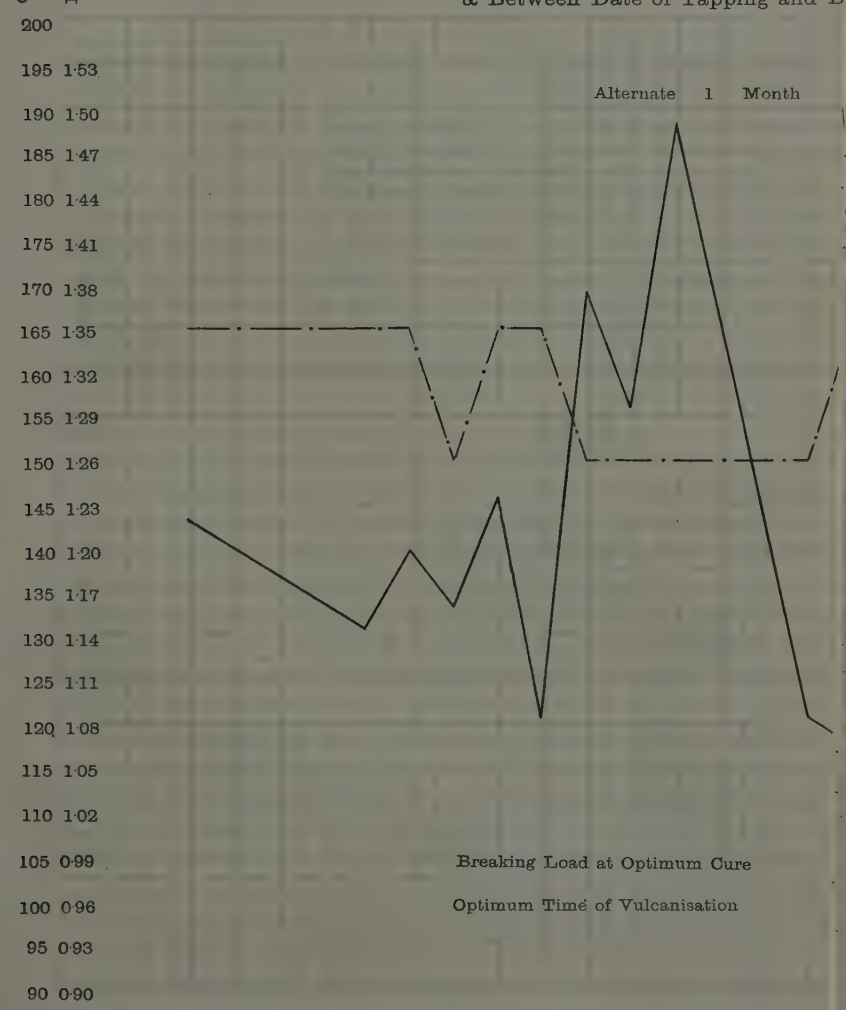

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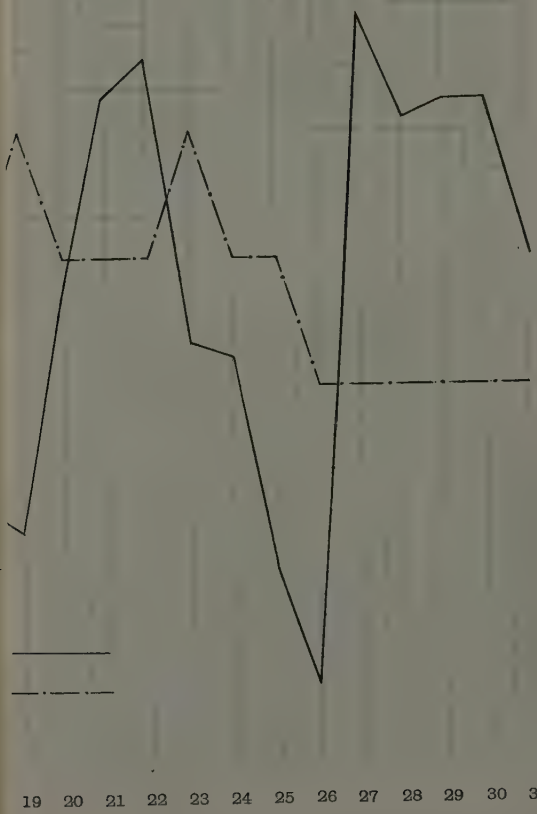

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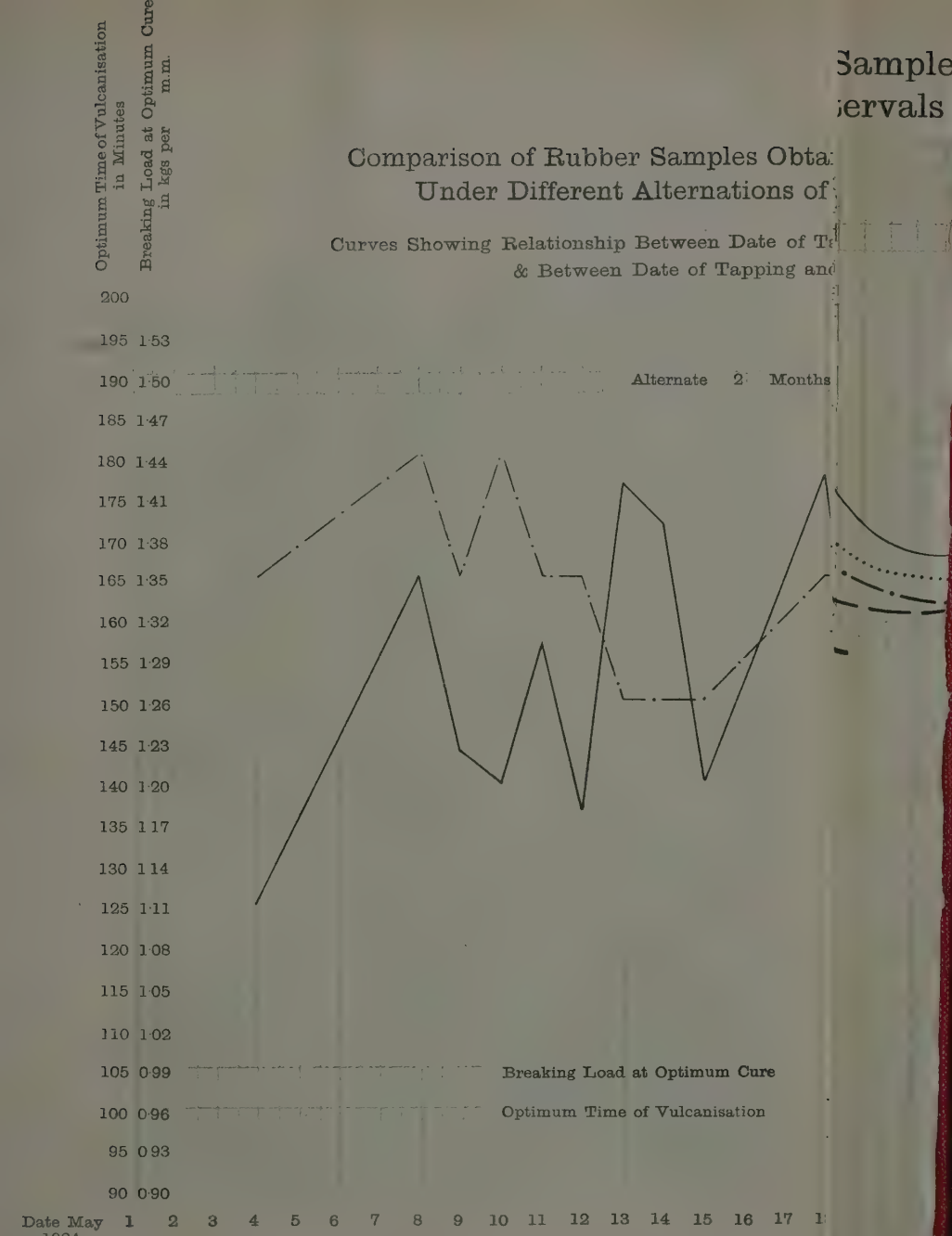

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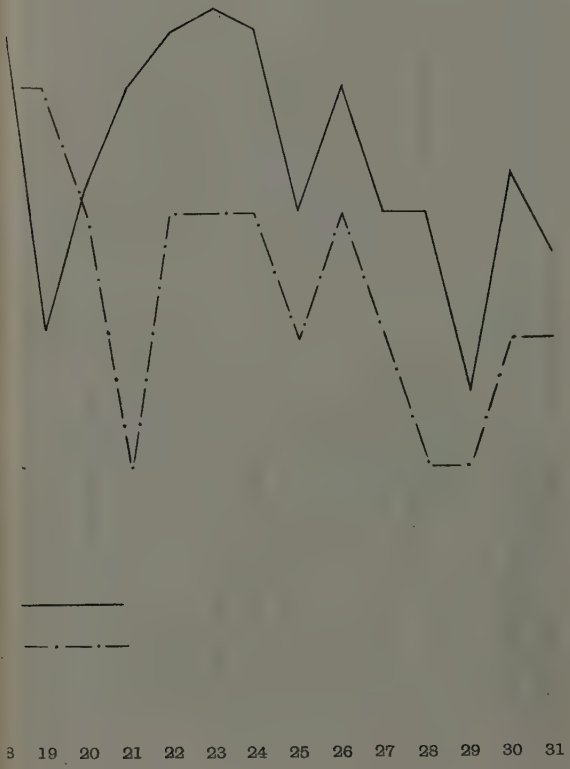

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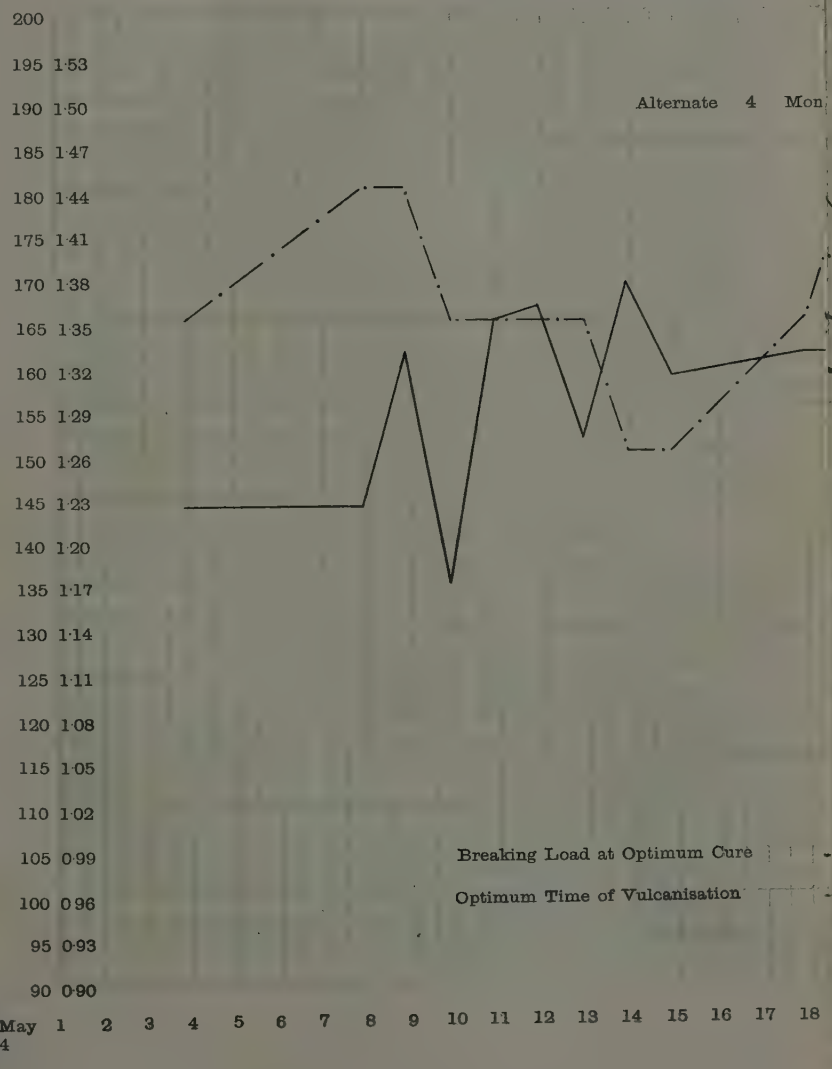

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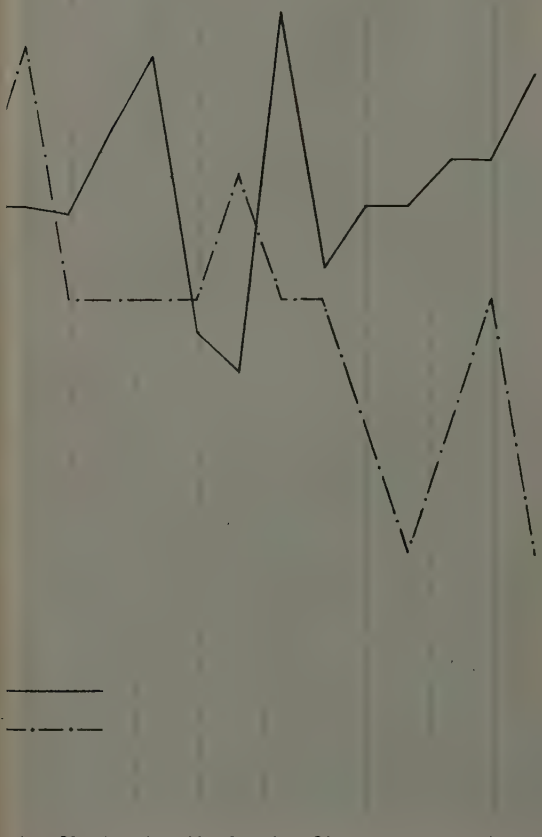

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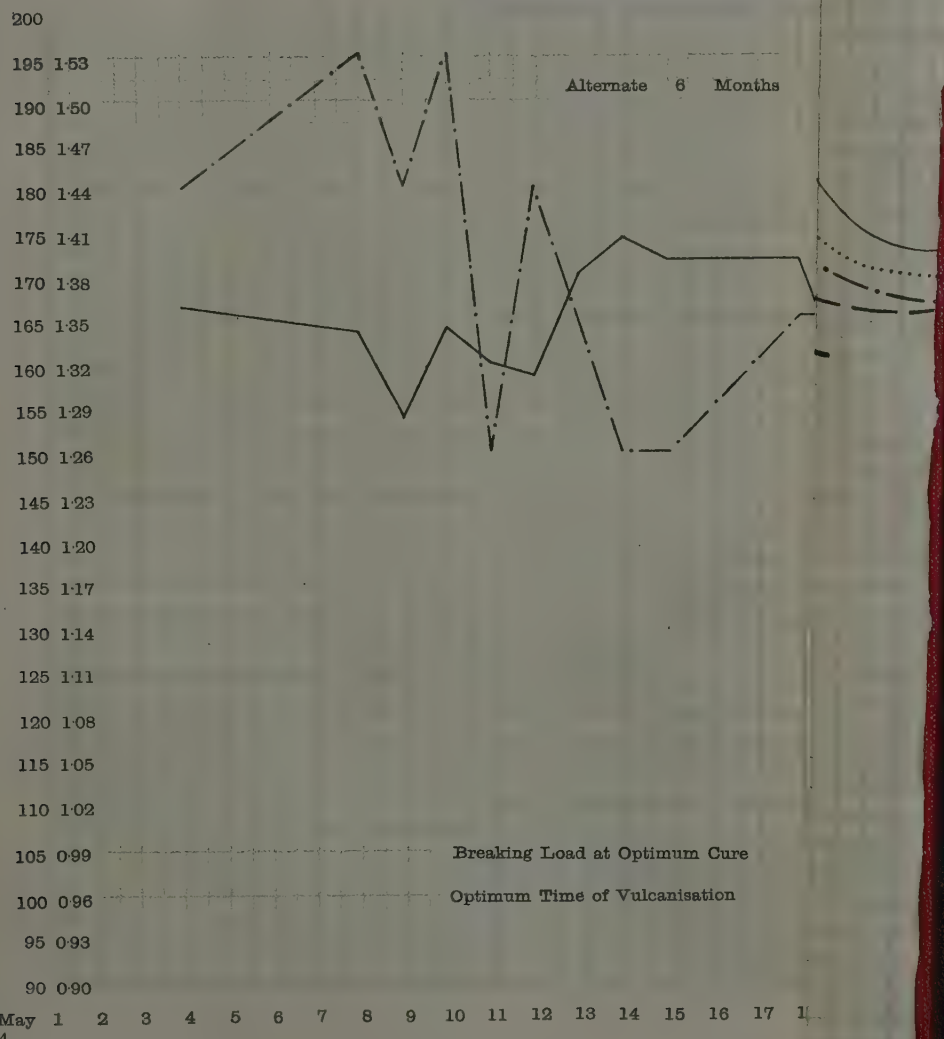
Curves Showing Relationship Between Date of Tap
& Between Date of Tapping and



14 15

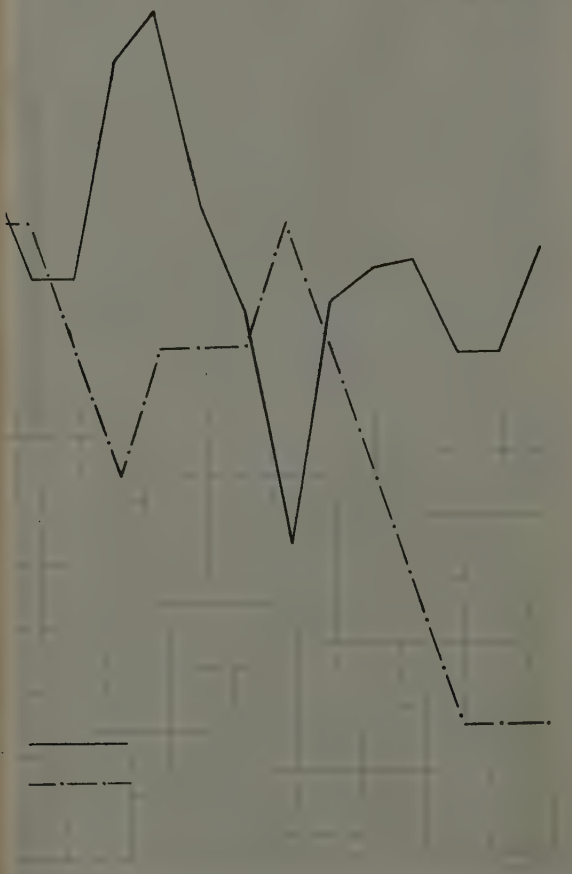
ays after

ıed from Trees Tapped
Tapping & Resting

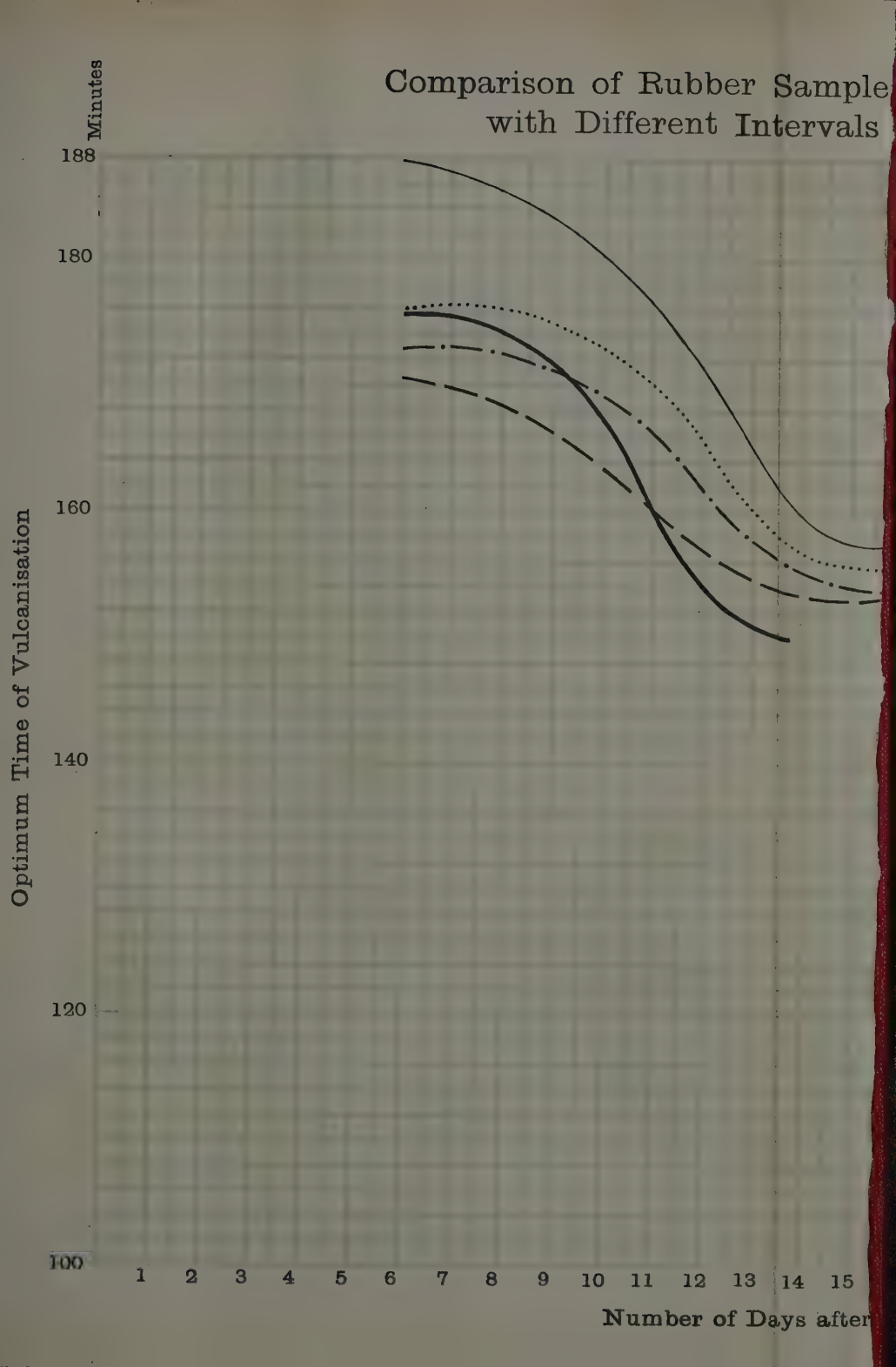
ping and Rate of Vulcanisation
Breaking Load

I

DIAGRAM [redacted] E.

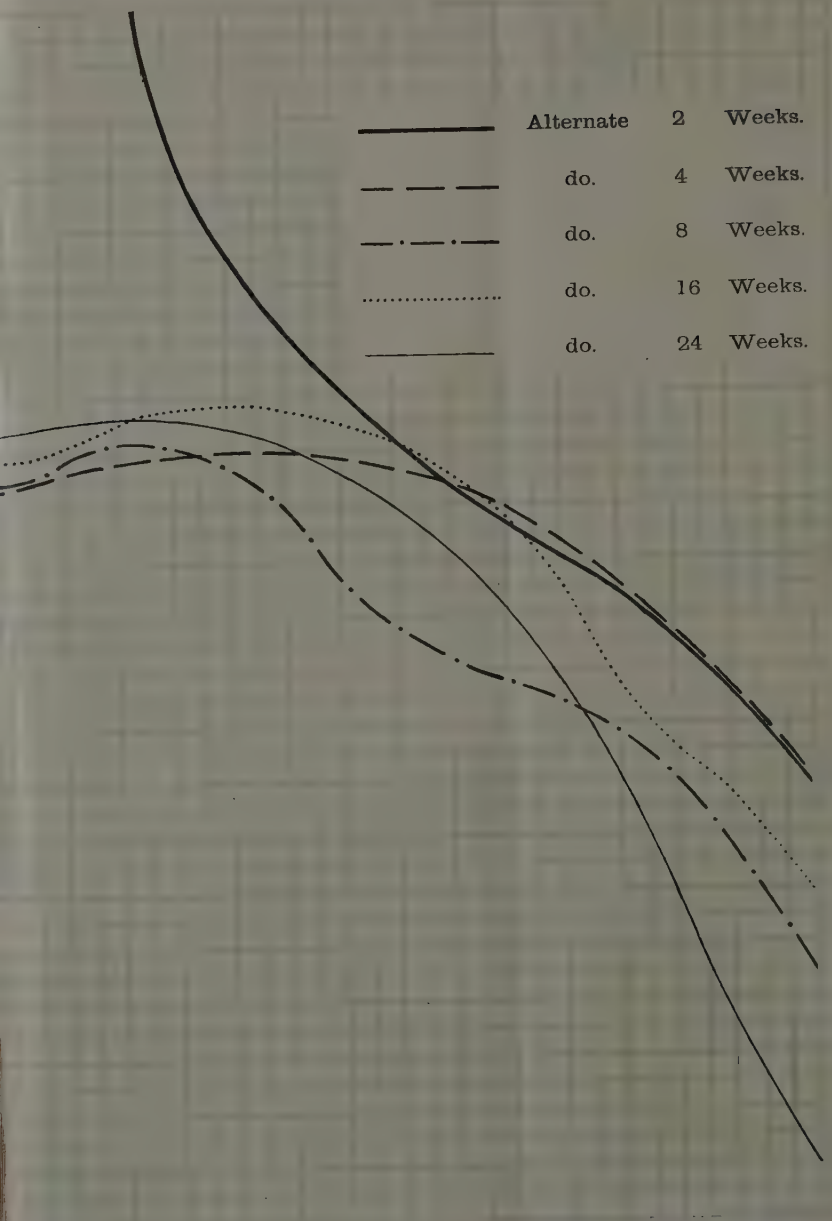


Drawn and Printed by F. M. S. Surveys No. 281 - 1925.


Comparison of Rubber Sample
with Different Intervals
Minutes
188
180
160
140
120
100
Optimum Time of Vulcanisation
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Number of Days after

obtained from Trees Tapped
f Tapping and Resting.

Diagram II.



16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 Days.

Commencement of Tapping.

Drawn and Printed by F. M. S. Surveys No 291 - 1925

2 months', 4 months', and 6 months' periods, in order to ascertain whether any further change occurred in the rate of cure. The rates of cure in the case of the 4 months' and 6 months' samples at the end of one month's tapping are comparatively rapid for sheet rubber and have not yet become constant. It is possible that the rates of cure may become slower again, since sheet from normal tapping usually has a slower rate of cure than that of the samples under investigation at the end of the one month during which samples were tested.

It will be noted from Table III that, in several instances, the "Mean Breaking Loads" show a high coefficient of variability.

We have found from other experiments that a coefficient of variability above 15 per cent. is abnormal and that the usual figure is below 10 per cent.

For this reason, tests were repeated on these samples, but the coefficient of variability still remained abnormally high.

It is not possible at present to offer any explanation for these large deviations.

Conclusions.

From the results recorded above, the principal conclusion which can be drawn is that the alternation of tapping and resting affects the time of vulcanisation of the rubber.

The rubber obtained from trees tapped after a long period of rest has, during the early stages of renewal of tapping, a very slow rate of vulcanisation, which settles down to a constant and more rapid rate after about three to four weeks.

The irregularity of the tensile figures do not permit any definite conclusions to be drawn as to the actual tensile quality of the rubber, which appears not to be affected to any marked extent.

The results in respect of the effect of periodic tapping systems on the rate of vulcanization and tensile strength of the rubber confirm results published by de Vries and Spoon (Ref. Mededeeling van het Central Rubber Station No. 42, 1924).

According to de Vries' experiments, the rates of vulcanisation of rubber from trees tapped after resting periods of one month or less all fall within the "normal" region of cure (deviations up to 20 per cent of average) and most of them within the "uniform" region (deviations up to 10 per cent of the average.)

In our experiments however the rate of vulcanisation of the samples from the trees immediately after the short periods of rest, viz., $\frac{1}{2}$ month and 1 month, is as slow as for the longer periods of rest of 2 months and 4 months, but not quite as slow as for the resting period of 6 months. The final rate of vulcanization of the rubber from the trees rested for 4 months and 6 months is also faster than in the case of the shorter resting period, so that the total variation is greater for the longer resting periods.

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THE PADI FLY (*LEPTOCORISA* SPP.) IN KUALA PILAH DISTRICT.

By W. H. Barnes and F. W. South.

General.

THE "Padi Fly" or "Rice Sapper" is the popular name given to the various species of *Leptocorisa* which, both as nymphs and adults, suck the juices of developing grains of padi when they are in the milky stage. When present in large numbers these insects are capable of doing serious damage, as the following account shows. Five different species have been recorded from Malaya, Leptocorisa varicornis, F.; L. acuta, Thunbg; L. lepida, Bredd; L. Corbetti, China and L. costalis, H. S., all of which are known to Malays as "Pianggang" or "Chenangau." These insects are capable of living on certain grasses other than padi and on some sedges. Corbett succeeded in breeding *Leptocorisa*, probably *costalis*, through its complete life cycle from egg to adult on seven different species of grasses. In his article he gives a summary of the various species of grasses and sedges on which these insects have been recorded as feeding in different parts of the Tropics (M.A.J. Vol. XI. p. 213).

Numerous notes in the Malayan Agricultural Journal show that the Padi Fly is very generally distributed throughout Malaya. It is to be found in the majority of padi fields each year, though in such small numbers as to do little damage. Almost every season, however, it occurs sporadically in larger numbers in a few localities and destroys an appreciable portion of the crop.

History of the Pest in Kuala Pilah District in 1924 and 1925.

During the padi harvest early in 1924 there was a serious outbreak of these pests around Inas and Johol in Kuala Pilah district of the Negri Sembilan. The insects were present in such large numbers on certain of the padi fields (Sawah) near Inas that the crop was almost entirely destroyed and the Malay owners of these fields, who usually grow sufficient padi to supply their wants, were forced to purchase rice six weeks after harvest. Several fields around Johol were also badly infected and the crops from them were in consequence very small.

After harvest the insects were found resting on Resam (*Gleichenia linearis*), Kedudok (*Melastoma malabathricum*) Lantana and grasses, but in no case were they observed to be feeding nor were eggs found. The impression was obtained that the last brood of insects which reached maturity in the 1923-24 season remained alive without laying eggs until the following season's padi was in the right stage to provide them with a large supply of suitable food, when they again commenced to lay eggs.

In most fields in Kuala Pilah District several different varieties of padi with different maturation periods are planted, and planting is not all done at the same time, but may be continued over five or six weeks. Consequently there is a succession of plots of padi in the right stage to provide food for the padi fly and to support two consecutive generations. The natural result is, that, if left unchecked, these insects increase in numbers rapidly and completely destroy the later ripening plots.

During the intercrop season in 1924 efforts were made to find some substance which was attractive to the padi fly. Various essences and scents were used without success. Rotten meat was found to be slightly attractive but would not attract the insects from any distance.

It was known, however, that during the 1923—24 season a Malay at Inas had made a sticky mixture, such as is used for catching birds, and had caught a number of the adult insects by spreading the mixture on a piece of net attached to a bamboo and by waving the net over the tops of his padi plants. When thus disturbed the insects flew and were caught on the sticky mixture. By continually using this method he managed to preserve about one half of the crop usually obtained from his land, whereas his neighbours who did nothing lost practically all their crop. This method, or simple variations of it, was successfully used to control the attacks of these insects in the following season of 1924-25.

Early in the 1924-25 padi season the insects appeared in even larger numbers than in the previous season, at Inas, Johol, Ayer Mawang, Selaru, Ulu Pilah, Peraku and Gemaylang, all of which localities are in Kuala Pilah District. It was at once realised that unless they were destroyed before breeding there would be no padi in these areas.

It was observed that where the pest was plentiful individual owners working alone could not successfully control it. Definite organisation of all the workers who could be made available was clearly necessary. To achieve this the District Officer and his Penghulus and Malay Assistants co-operated with the Agricultural Field Officer, Negri Sembilan, and the local Malay Officers of his staff. The Forest Department assisted by supplying free a quantity of Keruing oil and by giving passes to Malays to obtain the necessary gums to make the sticky mixture.

The Agricultural Pests Enactment does not empower an Inspector to order anyone to work on land other than his own. It could not, therefore, be used to obtain the necessary workers. However, Land Rule Clause 23 B (iii) empowers the District Officers in Negri Sembilan to order any work for the common benefit. This rule was promptly applied and the whole population adjoining each sawah was assembled to combat the pest. The workers were organised into parties which were placed in charge of Malay Assistants, Penghulus and local Malay Officers of the Agricultural Department, all of who did much hard work in supervising the destruction of the pest and seeing that it was thoroughly done.

Methods Employed.

As already stated the principal method employed consisted of collecting the insects on various simple pieces of apparatus on which was spread a sticky mixture to which they adhered when touched by it.

It was most desirable, in order to avoid heavy expenditure, to use a method of destroying "padi flies" which required only such materials as the Malays could easily obtain for themselves, if possible free of any cost beyond the labour of obtaining and preparing them.

The method already referred to fulfilled this condition. The materials used for making the sticky substance were Keruing oil, presented free of charge by the Forest Department, mixed with either Jelutong, Getah Trap or Getah Grip which wild rubbers the Malays could obtain for themselves in the jungle. Jelutong was generally preferred.

When large quantities of adults were found the most effective apparatus on which to spread the sticky mixture consisted of a piece of old casting net 2 feet long by 1 foot wide which was stretched at one end of a bamboo 6 or 8 feet long and was waved among the flying insects and over the tops of flowering padi on which they had settled.

As the numbers of the insects decreased more handy implements were used. One form of implement was made from the leaf stalk and attached leaflet midribs of the Bertam palm (*Eugeissona tristis*). The leaf tissue was removed from the midribs of the leaflets and the midribs themselves were smeared with the sticky mixture. Another form consisted of a rough racquet of split bamboo. This was made by attaching thin pieces of split bamboo to the end of a stick in such a manner that they radiated like the ribs of a fan. Across these ribs thin strips of rattan were tied. The racquet was then smeared with the adhesive mixture. For collecting a few individual adults that might have escaped earlier collecting operations and for catching nymphs light wands or twigs were used, often by children. A length of about 6 inches at the end of each wand was dipped in the mixture. After being used for an hour or two, these wands had the appearance of a bullrush flower, the swollen part being composed of dead padi flies.

Where the nymphs were found in large numbers they were collected by shaking the infested heads of padi over pans of water mixed either with the juice of limes and wood ashes or with a little kerosene oil. The insects fell into the pans and were killed. The pans themselves were made by cutting kerosene tins in half lengthways.

The eggs, which were not found until the majority of the adults had been destroyed, were collected and destroyed. In this connection it should be remembered that the eggs are parasitised by hymenopterous insects. It is therefore preferable not to destroy the eggs but to put the portions of the leaves on which they are laid into cigarette tins and to place the tins in a dish containing a little water and

kerosene oil. When the nymphs hatch out they cannot escape, since they are unable to fly and on leaving the tins fall into the water and are killed. The egg parasites, however, emerge as adult flies and escape to continue their useful work.

The fact that the mature padi fly is not a strong flier and only travels a dozen yards or so before alighting is of assistance in using the described method of control, since those that escape collection on one occasion are found again at only a short distance. That the immature insect when disturbed falls to the ground and hides is also of assistance as is the fact that both nymphs and adults are not too easily disturbed.

Results Obtained.

The results obtained from this organised cooperative action were quite satisfactory. In all localities where the insects were reported in good time and where work could in consequence be undertaken promptly, very little damage was done by this pest and average padi crops were obtained. The following table shows the effect of the control measures. The crops are recorded in gantangs (gallons) per acre.

Locality.	Crop. 1923	Crop. 1924
Johol ...	104	188
Pilah ...	165	142
Sri Menanti ...	148	136
Ampang Tinggi ...	205	115

Johol crops were badly infected in both years. In 1923 no attempt was made to deal with the pest, in 1924 it was dealt with fairly thoroughly.

Pilah and Sri Menanti mukims had very few of the insects in 1923. In 1924 the attack was severe but was controlled.

Ampang Tinggi was fairly free from the pest in 1923. In 1924 infestation was severe but only part of the infested area was reported in time to be dealt with thoroughly.

The total area infested with padi fly and treated in the 1924-25 season was approximately 3,600 acres. Had nothing been done it is very probable that almost the entire crop from this area would have been destroyed.

Intercrop Season 1925.

Work has been continued on the control of the padi fly since the harvest of 1925. Malays have been encouraged to cut down and burn all grasses on the edges of padi fields to deprive the surviving insects of food. Swarms have been searched for and have been found in

weedy rubber holdings, or patches of jungle, where they were again resting on Resam and Kedudok. These swarms have mostly been destroyed when found by the method used in the padi fields.

It is of interest to note that in no case since the harvest have either eggs or nymphs been found, only mature insects. One swarm has remained in one locality for four months and has been under frequent observation but has not yet been known to produce eggs.

It is worthy of record that some of the insects in this last mentioned swarm were attacked by what appears to be a parasitic fungus, identified by the Mycologist as a species of *Hirsutella*. The number of insects attacked was however, small and the fungus cannot be regarded as exercising at present any effective control.

Conclusion.

1. Cooperative and organised use of an easily applied and inexpensive method of catching these insects provides an effective control.

2. It is important that all the padi in any one sawah (padi field) should come into flower as nearly as possible at the same time. This point is understood by Malays. It can be attained in permanently irrigated areas, where it should be enforced. It is, however, unattainable where water supplies are irregular.

3. It is important to destroy the padi fly when it first appears in small numbers.

4. It is important to clean the edges of padi fields from grass, so that the insects have no supply of food near the sawahs after the padi harvest.

5. After harvest swarms found in rubber holdings or in the jungle or elsewhere should be destroyed.

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THE EXPERIMENTAL CULTIVATION OF YAMS AT THE GOVERNMENT PLANTATION, SERDANG.

By J. N. Milsum and E. A. Curtler.

A collection of edible yams was received from the Botanic Gardens, Singapore, early in 1924. From this material two crops have been raised but as the results obtained from the first crop were from a few plants only, they are not included in the present paper. The second crop, harvested in October 1925, gave an average calculated yield of over seven tons of roots per acre for the whole collection of twenty-five races. Six races returned a calculated yield of over ten tons of roots per acre, while one race (No. 48) gave almost fourteen tons.

The yam is a starchy food and in certain parts of the tropics supplies the place of the potato. In the Malay Peninsula among the Chinese and to a less extent other nationalities, the sweet potato usually take this place. Europeans, however, are very conservative in the matter of food and so far rarely eat either yams or sweet potatoes. Yams might well be included in the diet of persons living in the Peninsula as they are not only very palatable, when properly cooked, but are similar in food value to the potato.

Races.

The races received from the Singapore Gardens were from the rich collection formed by Mr. I. H. Burkill, late Director of Gardens, Straits Settlements. Reports regarding the experimental cultivation of these yams in Singapore have appeared in the Gardens' Bulletin, S. S., during the past ten years. In many instances the roots have been illustrated and for the purpose of reference the registration number adopted by the Botanic Gardens, Singapore, is maintained.

The collection grown at Serdang consists of races of two species of *Dioscorea* i.e., *D. alata*, Linn, the greater yam, and *D. esculenta*, Burk., the lesser yam.

Dioscorea alata is a strong growing climber with quadrangular winged stems which twine to the right. The leaves are large, glabrous, and sharply angled. The tubers are frequently large, variously shaped and usually dark brown in colour. The greater yam is a native of the eastern tropics and has been known from the Indian Ocean to the Pacific for centuries. It is allied closely to some of the wild yams of Eastern Tropical Asia, but shows signs of considerable selection under cultivation.

Dioscorea esculenta is a thorny climber. The leaves are kidney-shaped at the base, pointed at the tip and somewhat hairy. The tubers are relatively small but produced in quantity. They are readily distinguished on account of their spiny persistent roots.

This species is less widely known than *D. alata* and its distribution more confined.

Description of Races Cultivated.

Dioscorea alata.

No. 10.—Origin Luzon, Philippine Islands. (No. 1057). Native name 'Tugui.' finger-shaped. Tuber medium size, unbranched. Sap magenta under the skin, flesh white. Illustrated Gard. Bull. (I). Vol. I, No. 9, fig. 2 on p. 299.

No. 28.—Origin College of Agriculture, Philippine Islands (No. 1095). Native name 'Tumuktok.' Tuber medium size, curved, flattened and somewhat fingered. Flesh white, with bright magenta sap under the skin. The elongated tubers curve in the soil. Illustrated Gard. Bull. Vol. I, No. 9, fig. I on p. 301 and Nos. 11—12, plate V, also Vol. III, No. 2, plate iii.

No. 30.—Origin College of Agriculture, Philippine Islands. (No. 960), Native name 'Ubag.' Tuber medium size, long, unbranched, with a tendency to produce twin tubers. Good for table (Burkill). Flesh white, with slight magenta sap under the skin. Illustrated Gard. Bull. Vol. I, No. 9, fig. 2 on p. 301.

No. 44 —Origin Bureau of Agriculture, Manila, P. I. (No. 1025). Name 'Ubi, red.' Tuber medium size, long, unbranched. Flesh white, magenta sap below the skin. Illustrated Gard. Bull. Vol. II, No. 2, plate ii.

No. 48.—Origin Philippine Islands (No. 2712). Tuber large branched. Flesh white, slight magenta sap under the skin.

No. 50.—Origin Bureau of Agriculture, Manila, P. I. Name 'White Bohol,' 'White Manila Yam.' (No. 824), Tuber large, lobed, somewhat flattened and branching. Skin very clean. Flesh white, which does not oxidise on exposure to the air, no magenta sap.

Illustrated Gard. Bull. Vol. II, No. 5, p. 158. Mr. I. H. Burkill refers here to a particularly large tuber of this race raised in Singapore. The tuber illustrated weighed 29 lbs. after being nine months in the ground. The circumference of the yam is shown as fifty-eight inches.

No. 64.—Origin Philippine Islands (No. 1040). Tuber large, lobed. Flesh white, turning brown quickly when exposed to the air, no magenta sap. A good table yam (Burkill).

No. 66.—Origin Philppine Islands. Name 'Ubi White'. (No. 1046). Tuber large, lobed, produced in cluster and descends deeply. Flesh white, turning brown when exposed to the air, no magenta sap.

No. 72.—Origin College of Agriculture, Philippine Islands. Name 'Sinawang pulo yam'. (No. 955). Tuber medium size, long, unbranched. Skin rather rooty. Flesh white. Sap magenta under the skin. A good table yam (Burkill). Illustrated Gard. Bull. Vol. I, Nos. 11—12, plate vi, and Vol. II, No. 2, plate iv.

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(1) Gard. Bull. refers to the Gardens' Bulletin, Straits Settlements.

No. 76.—Origin College of Agriculture, Philippine Islands. Name 'Sinanto'. (No. 958). Stem of plant prickly. Tuber large, lumpy and bulky, irregular in outline. Flesh ivory yellow, no magenta sap. Illustrated Gard. Bull. Vol. I, Nos. 11—12, plate ii, and Vol. II, No. 2, plate i and ii.

No. 100.—Origin Saigon. Name 'Khoai noc trang.' Tuber large, branched, somewhat flattened. Flesh white, magenta sap under the skin. A good table yam (Burkill).

No. 408.—Origin Saigon. Selected from 'Khoai Siam'. No. 98 in 1917. Tuber large, branched. Flesh white, firm, slight magenta sap under the skin. A distinctly late race (Burkill).

No. 410.—Origin Manila, P. I. Selected from No. 52 in 1917. Tuber medium size, unbranched. Flesh yellow, no magenta sap.

No. 498.—Origin Singapore. Tuber globular, branched. Flesh magenta with deeper coloured sap below the skin.

No. 510.—Origin Tahiti, Native name 'Ufi mene-mene'. Tuber globular. Flesh white with no magenta sap. Illustrated Gard. Bull. Vol. III, Nos. 1—3, plate opposite p. 4. Nos. 4 and 5.

No. 512.—Origin Tahiti, Native Name 'Ufi opura'. Tuber medium size, oblong. Flesh white, with no magenta sap. A good edible yam (Burkill). Illustrated Gard. Bull. Vol III, Nos. 1—3, plate opposite p. 4, No. 10.

No. 516.—Origin Tahiti. Native name 'Ufi paparatea'. Tuber long, unbranched, deep growing. Flesh white with slight magenta sap below the skin. A good yielder (Burkill). Illustrated Gard. Bull. Vol. III, Nos. 1—3, plate opposite p. 4. No. 2.

No. 518.—Origin Tahiti. Native name 'Ufi tiauu.' Tuber long, unbranched. Flesh white with slight magenta sap below the skin. A good yielder (Burkill). Illustrated Gard. Bull. Vol. III, Nos. 1—3, plate opposite p. 4. No. 9.

No. 530.—Origin Brunei. Tuber oval, short, lobes divergent. Flesh white, deep magenta sap below the skin. Illustrated Gard. Bull. Vol. III, Nos. 1—3, plate opposite p. 6, lower figure.

No. 548.—Origin Malacca. Tuber small, globular, produced in quantity. Flesh magenta with deeper coloured sap below the skin.

No. 622.—Origin Grik, Perak. 'Ubi junjong merah.' Tuber medium size, half-long, many roots persistent. Flesh magenta-purple with deeper coloured sap below the skin.

No. 632.—Origin Batu Gajah, Perak. Tuber long, branched, many roots persistent. Flesh yellow with magenta sap below the skin.

Dioscorea esculenta.

No. 270.—Origin Bureau of Agriculture, Philippine Islands. (No. 1063). Tuber short, branched. Flesh white. Heavy yielder, diffuse (Burkill).

No. 288.—Origin Saigon. Native name 'Khoai tu-bua.' Tuber short, branched. Flesh white. Good flavour, heavy yielder (Burkill.) Illustrated Gard. Bull. Vol. 1. Nos. 11—12, plate vii, lower figure.

No. 296.—Origin Akola, India. Native name 'Goradu' (No. 33346.) Tuber short, branched. Flesh white. Taste just sweet, fair yielder (Burkill.)

Cultivation.

The most suitable soil for yam cultivation is a sandy loam with a fair amount of humus. The plants, however, grow satisfactorily in clay or sandy soils. Stiff, heavy soils are unsuitable as the tubers are unable to develop properly The yam being a deep-rooted crop requires deep cultivation and thorough drainage to obtain high yields. The plants are best grown on ridges as in the case of sweet potatoes. In the present trials the ridges were placed 4 feet apart and the sets planted 2 feet apart in the ridges. The application of a dressing of well-rotted cattle manure results in more vigorous growth and increased yield of tubers.

Yams are propagated from sets taken from the mature tubers. The upper woody part of the yam, or that nearest the stem, is most ready to sprout and the basal part of the tuber least. (I) The former should therefore be used as sets. The length of time that elapses between planting the sets and the appearance of the shoots depends to a great extent upon the condition of the tubers. Tubers kept in a dark place for any length of time after lifting throw out strong shoots which grow rapidly, obtaining their nourishment from the tuber. In the present experiments the average period between planting the sets and commencement of growth was 22 days in the case of races of *D. alata* and 29 days with *D. esculenta.*

Periodical weeding should be attended to and the soil slightly stirred during dry weather to prevent excessive evaporation of moisture.

To obtain the best development of the roots, the plants should be staked with strong poles about ten feet in length. Experiments conducted in the West Indies show that in every case there was a large increase in yield from staked yams as compared with the unstaked ones, amounting to more than 100 per cent on the total yield (1).

Harvesting.

The maturity of the crop is indicated by the drying up of the leaves and general cessation of growth of the plant. The crop takes from nine to ten months to mature. Considerable care is necessary, in the case of the deep-rooting races, to lift the tubers without injuring them. Owing to this cause, the yam is more expensive to harvest than other root crops as usually individual digging is necessary.

(I) Gardens' Bulletin. S.S., Vol. I, No. 9 p 306.
'Different parts of the tubers of *Dioscorea alata* sprout at different rates.'

Yield.

The area planted in these trials was one chain wide, which allowed of 33 sets being planted in a row. In calculating the yields per acre, the weight of tubers obtained from each row are multiplied by 165 i. e., the actual number of rows at 4 feet apart which go to make up an acre. In a number of instances it was not possible to plant up an entire row with one race and the results in these cases are naturally less reliable than when an entire row of one race was harvested. These races are as follows:—Nos. 10, 28, 30, 498, 510, 530, 548, 622, 632. The results cannot be regarded as comparative but give an indication of what crops may be expected from yams grown under average conditions.

The weights recorded are those of the tubers after being thoroughly cleaned of all soil.

Table I.

The Greater Yam. *Dioscorea alata.*

Race Registration No.	Number of sets planted.	Actual yield lbs.	Calculated yield per acre lbs.
10	6	27	24,500
28	9	17	10,340
30	11	62	30,690
44	33	120	19,800
48	33	188	31,020
50	33	42	6,930
64	33	120	19,800
66	33	119	19,630
72	33	62	10,230
76	33	130	21,450
100	33	55	9,070
408	33	172	28,380
410	33	45	7,420
498	22	58	14,350
510	7	8	6,220
512	33	42	6,930
516	33	37	6,100
518	33	96	15,840
530	20	53	14,420
548	6	8	7,220
622	22	100	24,750
632	8	16	10,890

Average calculated yield per acre	... 7 tons
Average weight of tubers from each set	... 3 lbs.

(1) Gardens' Bulletin, S. S., Vol. II, No. 8, p. 301. 'Staking Yams'.

TABLE II.

The Lesser Yam. *Dioscorea esculenta.*

Race Registration No.	Number of sets. planted.	Actual yield lbs.	Calculated yield per acre lbs.
270	33	82	13,530
288	33	152	25,080
296	33	86	14,190

Average calculated yield per acre ... 7·8 tons.
Average weight of tubers from each set ... 3 lbs.

TABLE III.

A good tuber of each race was weighed and the results are shown in the following table.

Race Registration No.	Species.	Weight of tubers. lbs.	ozs.
10	*Dioscorea alata*	2	4
28	,, ,,	1	14
30	,, ,,	5	8
44	,, ,,	6	4
48	,, ,,	15	—
50	,, ,,	3	12
64	,, ,,	9	8
66	,, ,,	11	—
72	,, ,,	2	8
76	,, ,,	7	4
100	,, ,,	7	6
408	,, ,,	10	8
410	,, ,,	2	8
498	,, ,,	5	—
510	,, ,,	1	8
512	,, ,,	4	8
516	,, ,,	6	12
518	,, ,,	4	4
530	,, ,,	2	12
548	,, ,,	1	4
622	,, ,,	3	6
632	,, ,,	4	—
270	*Dioscorea esculenta*	1	2
288	,, ,,	1	10
296	,, ,,		8

SUMMARY.

Twenty-five races of yams are enumerated and the tubers described briefly.

2 The cultivation of the crop is outlined.

3 The yields obtained from these races under cultivation at Serdang are recorded. The crop was nine months in the land and yielded a calculated average return of 7 tons of tubers per acre.

Preparation of Yams for the Table.

In the East the proper preparation of yams for the table is not generally understood therefore the following recipes are reproduced from one of the publications of the Imperial Department of Agriculture for the British West Indies.

Roasted Yams.—Lay a yam before the grates of the stove or in the oven, turning it occasionally until cooked, scrape off the outer skin, cut into pieces or mash with butter; serve hot.

Baked Yams.—Pare a yam, put it in the oven and bake until soft, take it out of the skin, mash with butter, put back into the skin; cut in piece and serve hot.

Boiled Yams.—Pare a yam, put it into boiling water, cook until tender; serve whole.

Yam Chips.—Pare a yam and boil until tender, cut it in chips; fry in boiling lard and serve hot.

Yam Rice.—Pare a yam and boil until tender; press through a colander into a hot dish; shaking the colander lightly every few seconds, to cause the yam to fall off in short grains like rice; serve very hot.

Yam Rissoles.—Pare, boil and mash a yam with pepper and salt, and if liked, a little minced parsley; shape into rissoles, cover with egg and bread crumbs, and fry until a light brown.

Yam Border.—Pare, boil and mash a fairshaped yam, about two pounds in weight, and add to it two tablespoonsful of butter, half a cup of boiling milk, one tablespoonful of salt, the yolk of two eggs (well beaten); beat the mixture until very light; butter a border mould, pack the yam in it, and let it stand for eight minutes, beat the whites of the eggs to a froth, add salt, turn out the yam, cover with the whites and put in an oven to brown; take from oven and fill the centre with meat or flesh heated in a sauce.

Yam au Choux.—Take one pound of boiled yam, one boiled cabbage, two teaspoonsful of cream one ounce of butter, with salt and pepper to taste; rub the yam and cabbage through a wire sieve, mix

together with butter, cream and seasoning; pile upon a dish, and serve with fried croutons of bread around. Serve very hot.

Porcupine Yam.—Take two pounds of yam, boil and mash with one egg and salt to taste; shape and roll in beaten egg and vermicelli; fry. Serve hot with parsley.

Yam Fritters.—Pare and boil half a pound of yam until soft, beat lightly with a fork; beat the yolks of four and the white of three eggs, and two spoonsful of cream, two tablespoonsful of wine, one dessert-spoonful of lemon juice and half a teaspoonful of grated nutmeg; beat all altogether until extremely light, put plenty of lard into a frying pan and drop a tablespoonful of the butter at a time into it, and fry the fritters to a nice brown. Serve with wine sauce (served separately), or only sprinkle powdered sugar over them.

Yam Pudding.—Take half a pound of yam, two eggs, one lemon, two ounces of butter, two ounces of sugar; pare and boil the yam, and rub it through a sieve while hot; beat the butter and the yam together, and allow the whole to cool; break the eggs and separate the yolks from the whites; beat the yolks until light, and add sugar, the juice of a lemon as well as the grated rind, and the yam. Whisk the whites to a stiff froth and stir lightly in before baking; put in a well buttered dish and bake in a brisk oven for twenty minutes.

Yam en Brun.—Cut up one pound of yam already boiled, and fry to a light brown; sprinkle thickly with chopped parsley and shalat or mushroom, pepper, salt and lime juice; serve very hot.

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REPORT ON THE RAT CAMPAIGN IN KRIAN BETWEEN THE PERIOD MAY 15TH & END OF AUGUST, 1925.

By Frank Birkinshaw.

A. Resume of Experience Gained in the six Months of the Campaign over a Restricted Area.

ONE of the objects of the Rat Campaign begun in 1924 over a restricted area in Krian was to gain information as to the most effective way of dealing with the rat problem in padi fields. (M. A. J. Vol. XIII No. 6 p. 168).

2. Experience gained in this preliminary Campaign showed that the most effective methods of rat destruction under the circumstances were trapping by Malays and organised hunting by Tamil coolies. School children materially assisted in the trapping. Organised hunting on any large scale was entirely confined to P.W.D. coolies, the hunts being organised by the P.W.D. This Department rendered great assistance in this way. No organised hunting was done by Malays although both European Officers made attempts to get it commenced on a systematic basis. Poison baits never became popular. The usefulness of poison gas in holes was found to be extremely limited as holes are not numerous and occupy much time in finding: even then only a proportion of the holes were found to be occupied.

B. Inauguration of an Organisation for an Extended Campaign.

The results of the Campaign over the restricted area were considered sufficiently good to warrant an extension of the Campaign to the whole of Krian District for the next season. This extended Campaign was commenced on May 15th 1925.

2. The organisation consists of one European Officer (Rat Destruction Officer) and five Malay Officers. The Rat Destruction Officer was Mr. Lindsay Vears up to July 4th (when he resigned) and Mr. G. S. Sutherland (who is still in charge) from July 9th.

3. The Malay Officers are in charge of defined areas. Their duties are to visit Ketuas regularly and to check the number of tails tendered by them and by others, reporting totals to the Rat Destruction Officer on his weekly visits. Each officer makes a regular tour of the area allotted him, reports to the Rat Destruction Officer when and where fresh traps are needed, if poisons are required and assists the Rat Destruction Officer generally in the encouragement of rat destruction, both as regards the cultivators and the schools within the area allotted him.

4. The Rat Destruction Officer makes a weekly visit to the area under each Malay Officer when he pays rewards for rat tails (at one

cent a tail) tendered by Ketuas, other cultivators and by school children. School masters are held responsible for keeping an account of the number of tails brought in by their scholars, although the Rat Destruction Officer makes weekly payments direct to the scholars. Thus the Rat Destruction Officer is engaged on five days every week visiting Malay Officers. One day, Friday, is reserved for office work, making up accounts and for any special work apart from the fixed routine.

C. Comparative Statement of Results.

Up to the middle of May the Campaign over the restricted area had yielded just over 100,000 rats in the following proportions (in round figures):—

Cultivators	...	17,000
Schools	...	28,500
P.W.D.	...	36,500
Total	...	82,000

To this total has to be added 24,000 rats reported by Ketuas to have been killed but for which no tails were seen nor any payment made, excepting that they were included in calculations made when selecting Ketuas for Special Rewards at the end of the last padi season.

2. It was decided that the acceptance of "Reported Killed" was unsatisfactory, so since the inauguration of the extended Campaign nothing is recorded unless tails are produced.

3. Between May 15th and August 28th, a period of 3½ months, over 195,000 rats have been killed. The proportions are:—

Cultivators	...	70,578
Schools	...	79,683
P.W.D.	...	45,394
Total	...	195,655

4. During the preparation of the fields for planting an attempt was made to encourage co-operative killing of rats by cultivators in the bendangs. The object aimed at was for each cultivator to leave a small area of uncut vegetation as a shelter in which rats would congregate. It was intended that adjacent cultivators should co-operate in cutting these isolated areas and in killing all rats that would have taken cover therein. The District Officer made at attempt to encourage rat destruction on these lines by fixing dates for rat drives in various localities. Notwithstanding these efforts it cannot be claimed that any very great simultaneous massacre of rats took place, although a certain amount of success was attained as shown by an increase in the weekly total of tails tendered. Not only so, but from enquiries made it would

appear that a large majority of the tails tendered throughout August were obtained from rats killed in the field by cultivators and not from trapping. This applies to tails tendered by school children as well as by cultivators: the children having obtained tails from rats killed on the lands of their relatives.

D. Brief Remarks on present position and indication of future lines of the work and aims.

To sum up, the present position is that trapping by Malays and rat hunts by Tamil coolies are the most successful methods of rat destruction in Krian.

2. Experience gained indicate that:—

(a) The use of poisoned baits has been effective only in certain localities and over short periods. No general success can be claimed for this method so far. The probable reasons are, (a) that rats quickly get suspicious of the baits and avoid them and (b) that the cultivators are not keen upon using them whilst rewards are being paid for tails as rats poisoned by one cultivator generally go to anothers land to die. Further experimental work with this method is advisable, but any undue pressure to force cultivators to use poisoned baits is unlikely to meet with success.

(b) Poison gas of any description for use in burrows is unlikely to be of any practical use in Krian. Burrows at no time of the year are sufficiently numerous to warrant spending the time required in searching for and treating them. A hunt by Tamil coolies will yield a greater return at less expenditure of time and labour.

(c) There are great potential possibilities from organised cooperative killing by the cultivators during "Menajak," but such organisation on a large scale will need much fostering before it can become a practical proposition.

3. Damage by rats to nurseries this year, as far as I can gather, has been nil. Only time will show if the same immunity will be enjoyed by padi plants and grain in the field as a result of the Campaign. If rat damage to the present crop should prove to be immaterial the money and labour spent on the Campaign will have been well worth while and a great incentive will have been provided to the cultivator to continued assiduity in rat destruction

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price $5.00 per volume.
Vol. V (1917) Nos. 1, 2, 3, 5 & 6 „ 250 per set.
„ VII (1919) „ 2—6 „ 4.50 „
(Vol. VI is out of print.)

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922) Price $5.00 per volume.
„ XI (1923) Price $5.00 per volume or 50 cents per single number.
„ XII (1924) „ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price $1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co

4. *Special Bulletins.*

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher.
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